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Mortality Risks for Forest Trees Threatened with Gypsy Moth Infestation

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Abstract

Presents guidelines for estimating potential tree mortality associated with gypsy moth defoliation. A tree's crown condition, crown position, and species group can be used to assign probabilities of death. Forest-land managers need such information to develop marking guides and implement silvicultural treatments for forest trees threatened with gypsy moth infestation.

There is growing interest in using silvicultural treatments to create forest stands that are less vulnerable to mortality after defoliation by gypsy moth.¹ To implement silvicultural treatments, however, forest-land managers need guidelines to help predict the probability of individual tree mortality associated with defoliation.

In this study, we have applied a multi-variable screening procedure to derive mortality probabilities for individual trees faced with defoliation by gypsy moth. The procedure has identified key characteristics from among many forest stand and tree conditions thought to be good predictors of tree mortality. Previous work based on the gypsy moth outbreak in northeast Pennsylvania (Pocono region) pointed to tree crown condition, species, and aspect as important predictor variables (Herrick 1982). Similar procedures applied to data from more recent infestations in central Pennsylvania have selected tree crown position in addition to crown condition and species as the best tree mortality predictors.

The Study

Data

Data for the analysis are from the gypsy moth episode of the early 1980's in central Pennsylvania. Cumulative tree mortality was measured from 1979 through 1985 on 574 one-tenth acre plots established in 1978 before infestation. Tree and timber stand characteristics thought to be potential predictors of tree mortality formed 43 variables for analysis. Rationale for their inclusion was based on findings of Campbell and Sloan (1977), Houston and Valentine (1977), Herrick et al. (1979), and Herrick (1982). All variables are easy to measure and account for some dimension among the following attributes:

Stand size-composition	Site index
Tree diameter	Land capability
Species	Elevation
Stand age	Aspect
Crown position	Slope
Crown condition	Position on slope

Analysis

Automatic Interaction Detection (AID) analysis (Sonquist et al. 1973) was used to generate a set of probabilities for individual tree mortality in gypsy moth infested stands. AID is an iterative technique that partitions the observations (14,684 trees in this study) through a series of two-way splits into subgroups. Each tree is a member of one of the subgroups. The subgroups formed at each step of the pro-

¹Gottschalk, Kurt W. [In preparation.] Silvicultural guidelines for forest stands threatened by gypsy moth. Gen. Tech. Rep. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station.

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cedure reduce the variance of the dependent variable (tree mortality) more than any other pair of subgroups that could be generated. Results are most readily visualized as a branching diagram that details the mortality configuration for individual trees in response to gypsy moth infestation.

Results

AID analysis of individual trees retained only three of the many characteristics analyzed as independent variables in its classification of tree mortality: tree crown condition, crown position, and species. A significant relationship exists between each of these variables and tree mortality.

Trees with poor crowns (more than 50 percent dead branches, very thin foliage, or heavy sprouting) have low vigor and are more likely to die after defoliation:

Crown condition	Cumulative mortality 1979-85 (Percent)
Good	10
Fair	21
Poor	49

Suppressed trees are often environmentally stressed and less likely to survive the added stress of defoliation:

Crown Position	Cumulative mortality 1979-85 (Percent)
Dominant & co-dominant	14
Intermediate	18
Suppressed	28

Oaks, especially black and chestnut oak, are favored food of the gypsy moth larvae and are usually attacked more severely than other tree species, leading to higher death rates:

Species	Cumulative mortality 1979-85 (Percent)
Black and chestnut oak	25
Other oaks	19
Other species	14

The AID analysis delineated ten final groups of trees and the probabilities of mortality in each group (Fig. 1). Black and chestnut oak trees with intermediate or suppressed crown position, and poor crown condition (Group 1), had the highest probability of mortality; 64 percent, as compared to 19 percent for the total sample. This group comprised 4 percent of the total sample. Trees of other oak species that are intermediate or suppressed and have poor crowns (Group 2) also had high (54 percent) probabilities of mortality.

The combination of fair tree crown condition, intermediate or suppressed crown position, and oak species gives a tree a 35 percent probability of mortality (Group 5).

Trees with good crowns have the lowest mortality prospect; even black and chestnut oaks rated only a 1 in 8 chance of dying if they had good crowns and dominant or co-dominant crown position before the outbreak (Group 9).

Tree mortality figures for all combinations of crown condition, crown position, and species group in the central Pennsylvania gypsy moth episode are shown in Table 1. Again, the importance of these predictors—especially crown condition—as key indicators of potential mortality is clear. Regardless of species or crown position, more than one-third of the trees with poor crowns died. In each species group, vulnerability was also consistently greater for trees with suppressed crown position versus intermediate or dominant and co-dominant positions. More than one-third of the suppressed black and chestnut oak trees died; even those that had good crown condition prior to infestation.

Table 1—Percentage of tree mortality associated with gypsy moth in central Pennsylvania (1978-85), by initial crown condition, crown position, and species group.

Crown condition	Crown position	Percent		
		Black and chestnut oak	Other oak	Other species
Poor	Suppressed	67	62	48
	Intermediate	60	41	39
	Dominant and co-dominant	35	42	40
Fair	Suppressed	44	46	22
	Intermediate	31	30	19
	Dominant and co-dominant	17	14	14
Good	Suppressed	34	19	13
	Intermediate	21	13	6
	Dominant and co-dominant	13	8	5

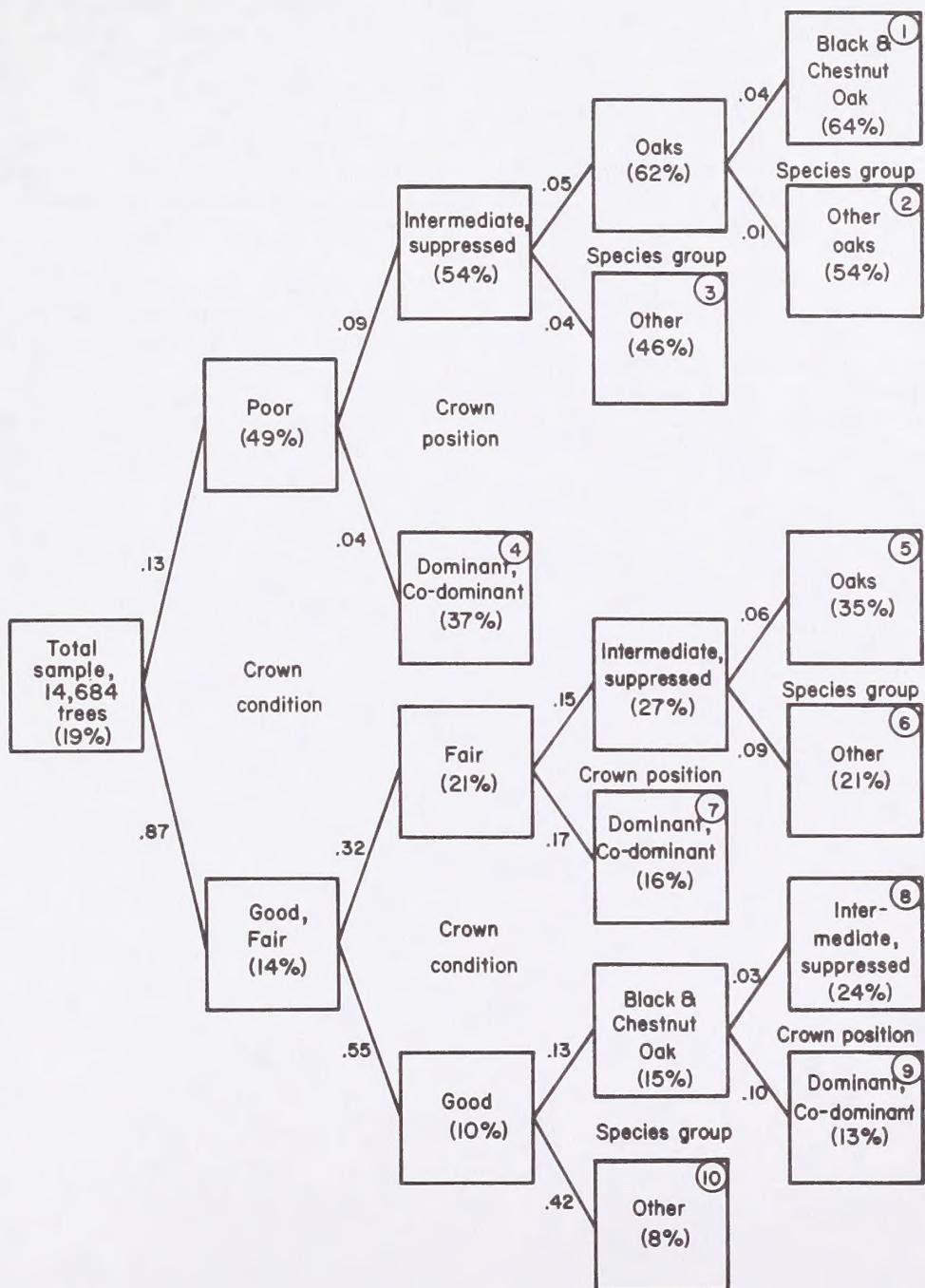


Figure 1.—Guide for estimating relative risks of tree mortality in areas expecting new infestation by gypsy moth. Any tree can be assigned to a mortality group representing its characteristics. Average probability of tree mortality in our Pennsylvania study is shown in parentheses for each group. Fractions on each line connecting groups show the portion of the sample in that group. Circled numbers indicate the 10 final groups delineated by the AID analysis.

Conclusion

This study describes a fairly simple structure that forest managers can use to assign relative mortality risks to individual trees threatened with infestation by gypsy moth. A tree's crown condition, crown position, and species group are the only information items needed to assign probabilities of death. This information will allow better evaluation of silvicultural proposals aimed at adjusting forest stand structure to reduce risks of mortality.

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